Fifth Annual Conference on Carbon Capture & Sequestration

Steps Toward Deployment

Capture Technologies

Intelligent Design of Solid Sorbents For Pre-Combustion CO_2 Capture

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Current CO_2 Capture Technology Systems Analysis Procedure

Laboratory Scale

- 0.1 ft^3 Reactor Volume
- 0.27 scf per minute

Technically Possible?

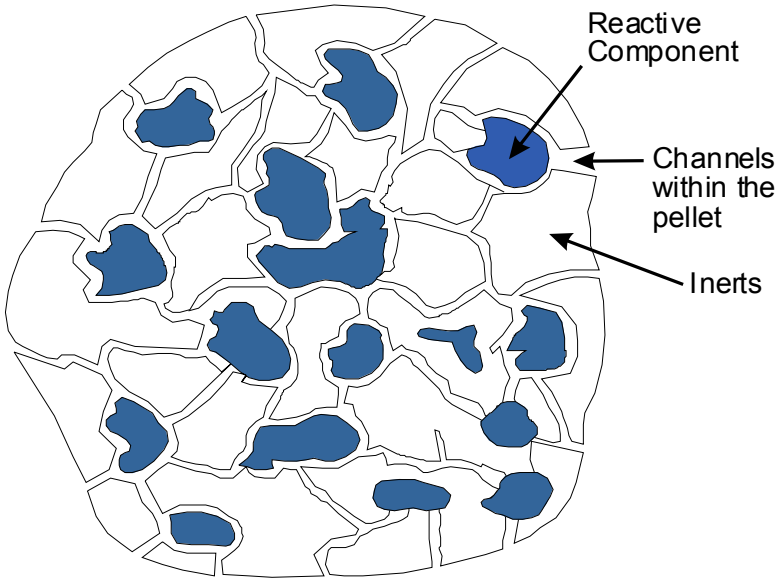
Analysis

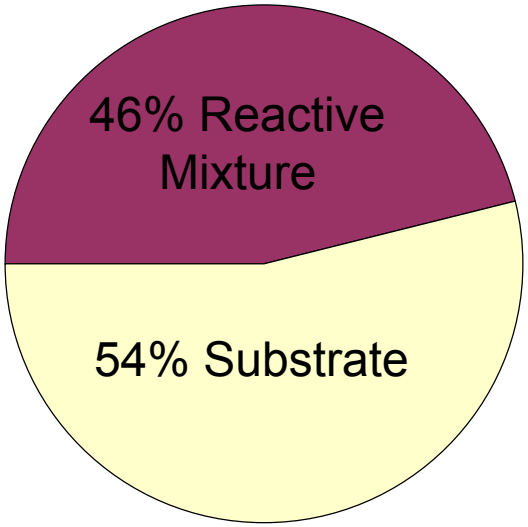
Economically Feasible?

400 MW Commercial Power Plant

- 57,000 ft^3 Reactor Volume
- 1,800,000 scf per minute

High Pressure, Low Temperature Sorbent Systems Analysis*

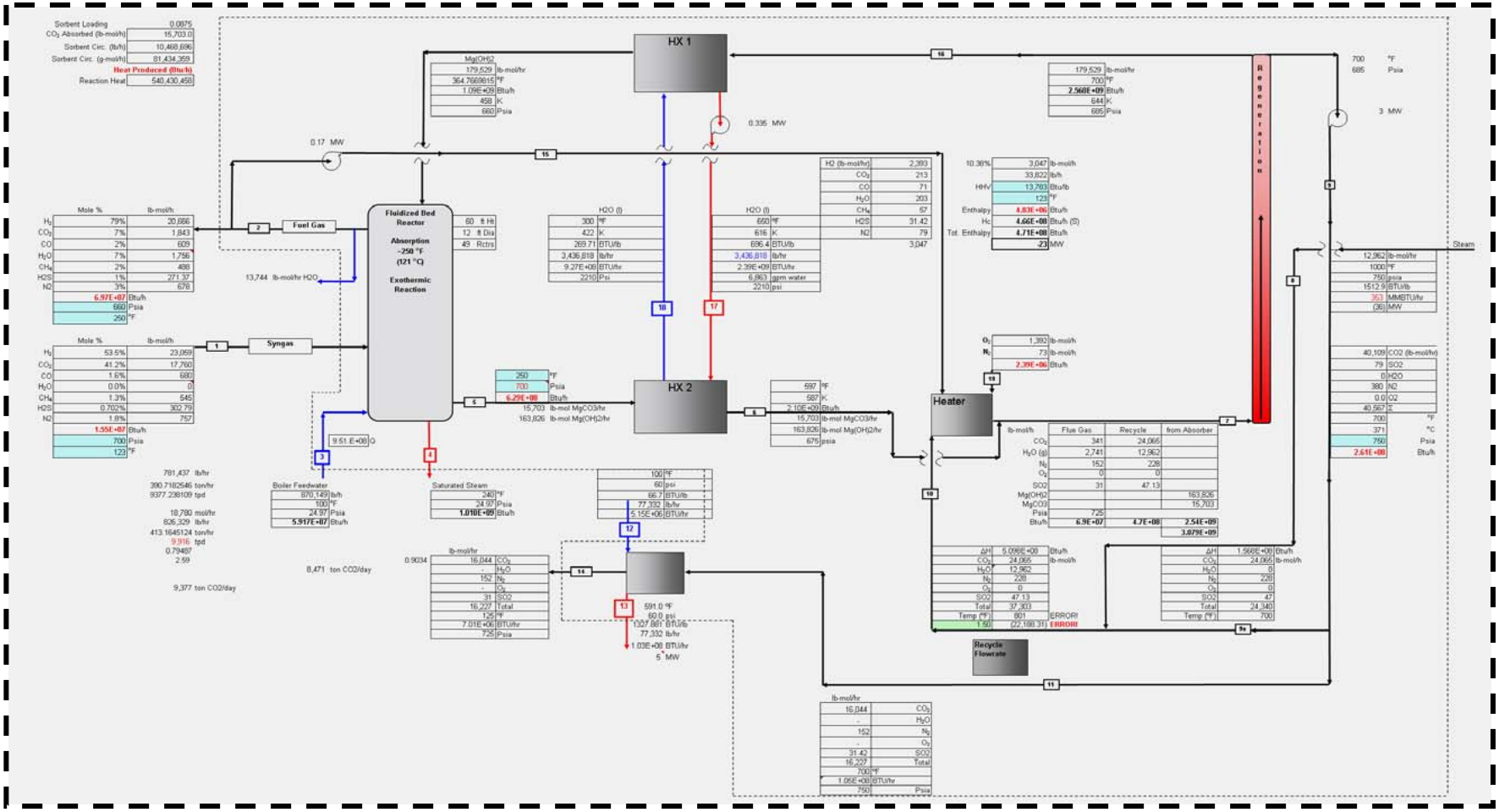




Capacity: >5 g-mol CO_2/kg sorbent (>100% increase over Selexol)

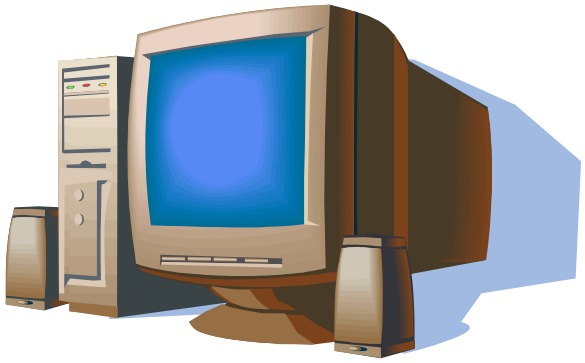
*Sorbent development by Dr. Ranjani Siriwardane, NETL

Heat and Material Balance-Based Approach



Preliminary Sorbent Development Analysis

Systems Analysis Group



CO_2 Absorption Capacity
Sorbent Cost

Makeup Rate
Regeneration Requirements
System Design

R&D

Goal: Provide R&D with sorbent performance targets that will lower CO_2 removal system costs

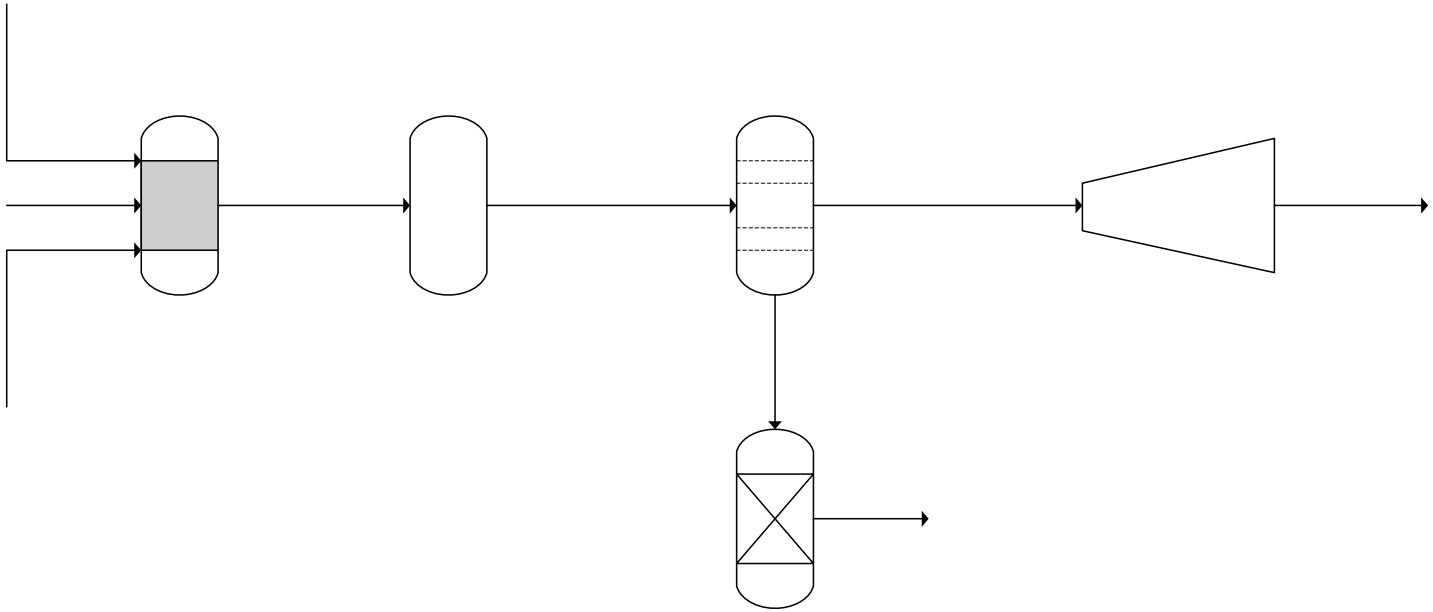
IGCC Plant Investment

Capital Expenses

IGCC Plant Capital
Power Island
Balance of Plant
Gas Cleanup

Operating Expenses

IGCC Operating Expenses
Capital Investment Fees
Production Costs



IGCC Plant Investment with CO_2 Capture

Capital Expenses

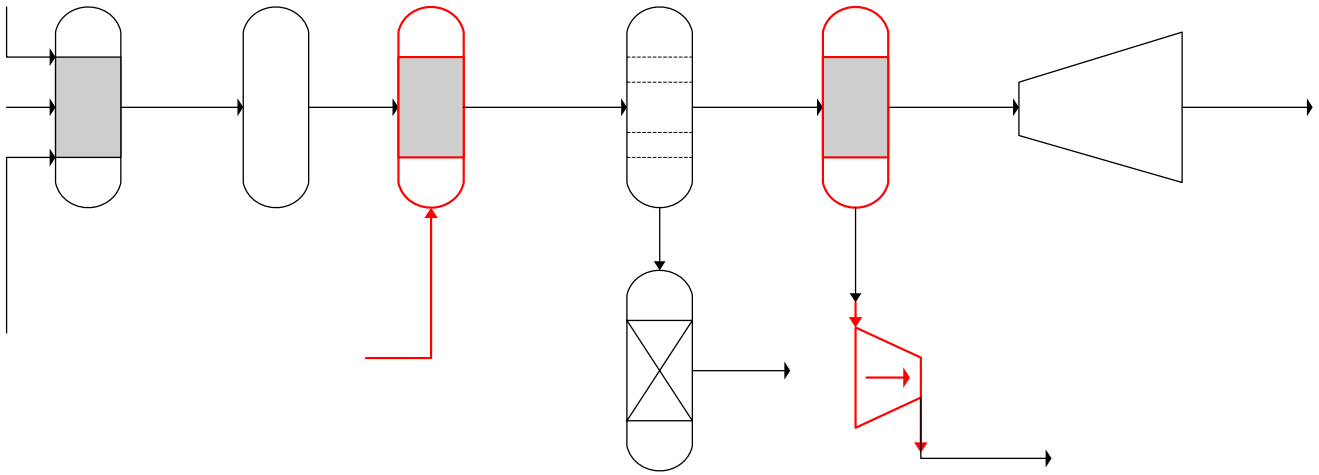
IGCC Plant Capital
Power Island
Balance of Plant
Gas Cleanup
-Water Gas Shift
-CO_2 Removal
-CO_2 Compression**

** Compression to 2200 psia

Operating Expenses

IGCC Operating Expenses
Capital Investment Fees
Production Costs
-Fuel*
-Sorbent

*Additional fuel required to make up for parasitic power loss



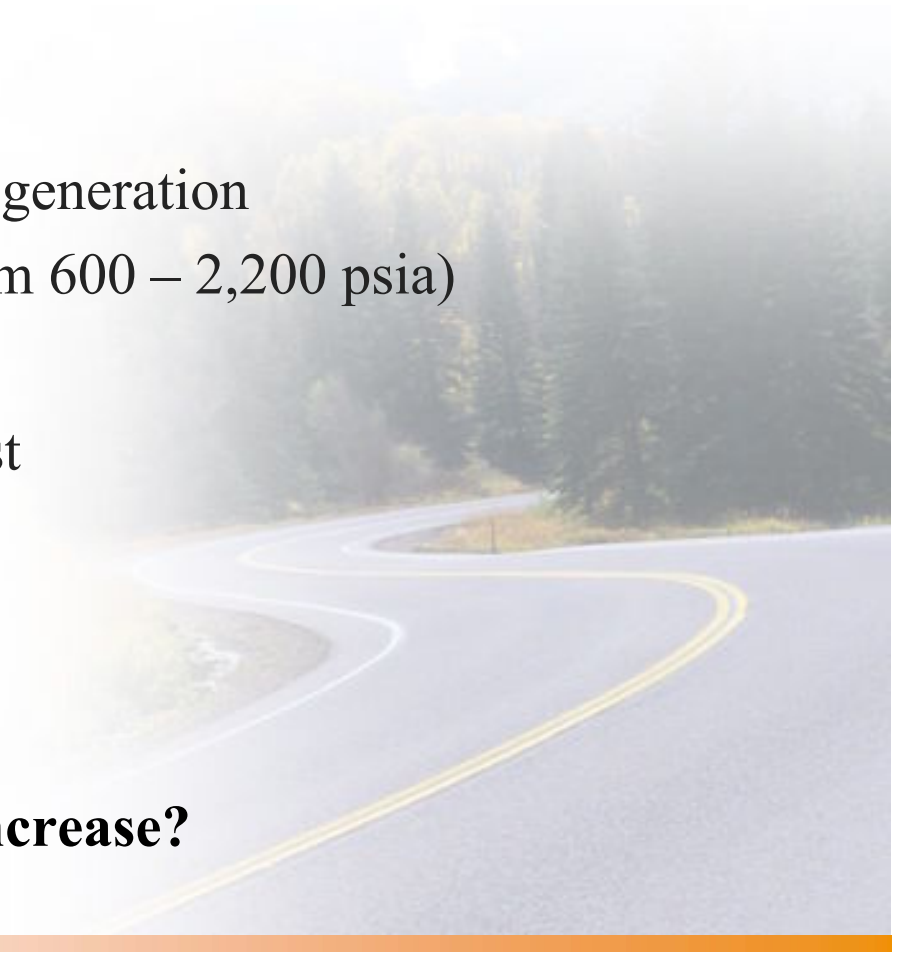
IGCC with CO_2 Control

- **If we assume:**
  - Free Sorbent
  - No Sorbent Makeup
  - Temperature Swing Regeneration
    (CO_2 Compression from 600 – 2,200 psia)

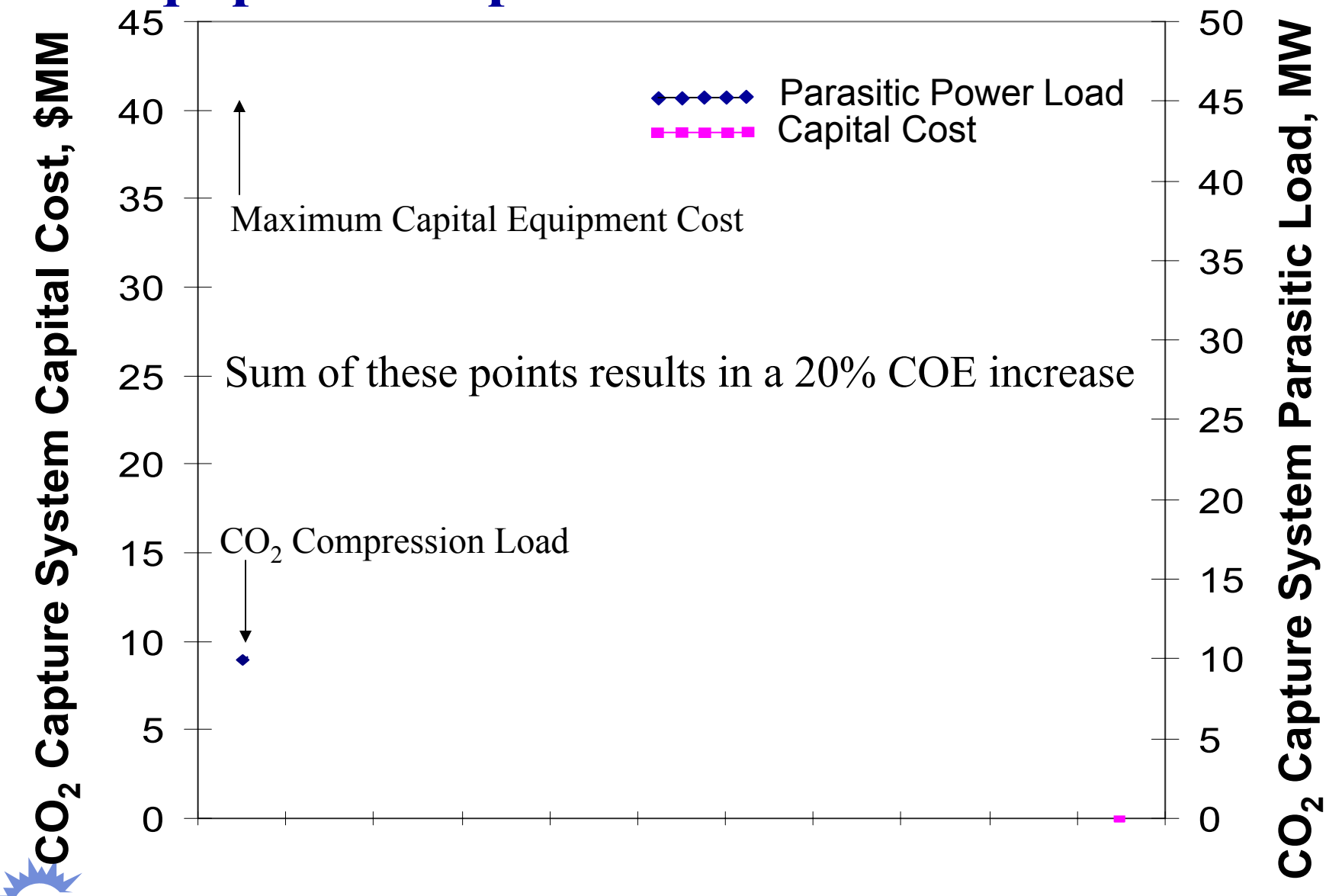
…and only consider:

  - Equipment Capital Cost
  - Parasitic Power Load

How much latitude do we have in achieving ≤ 20% cost of electricity (COE) increase?

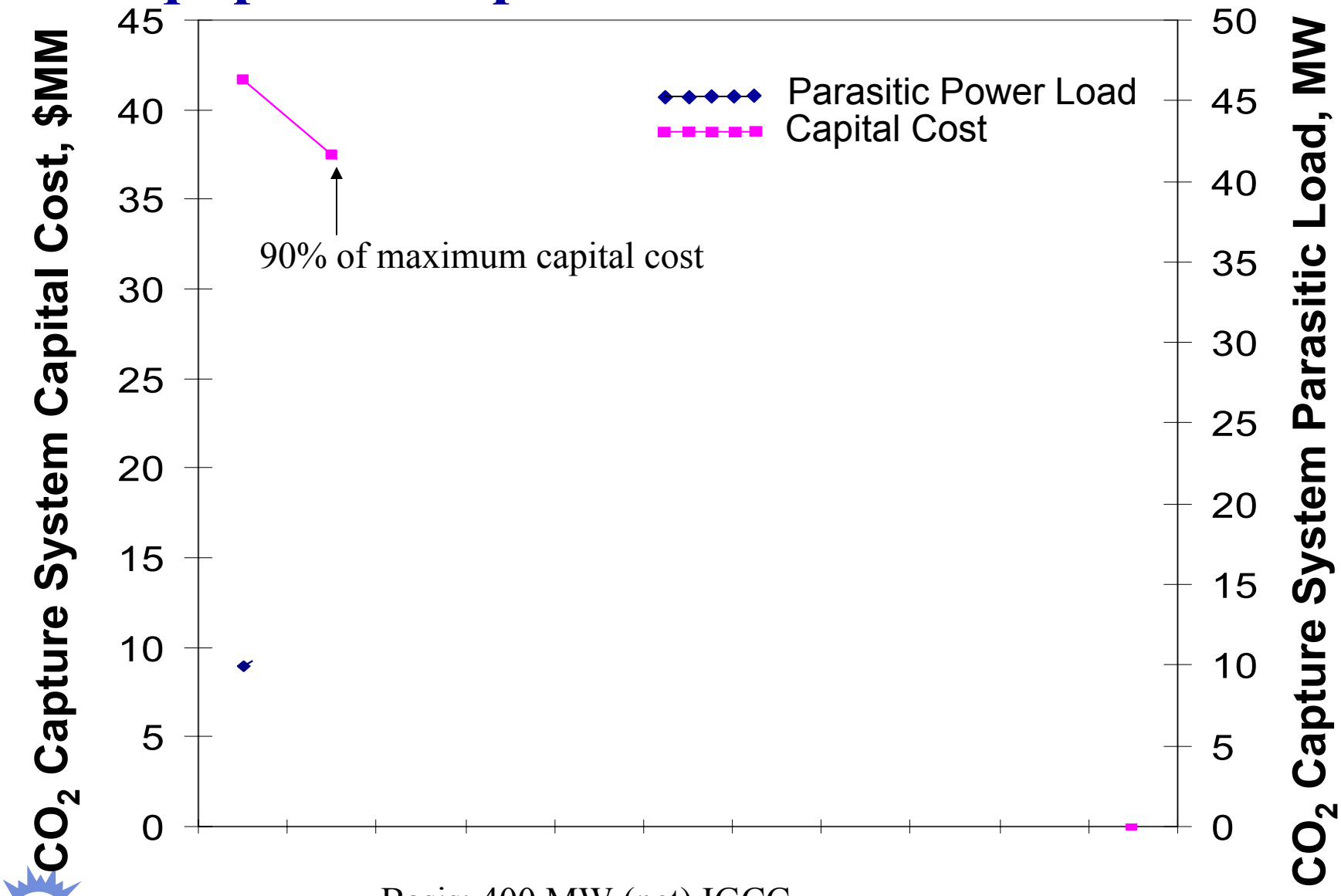


Equipment Capital Cost and Parasitic Load



Basis: 400 MW (net) IGCC

Equipment Capital Cost and Parasitic Load



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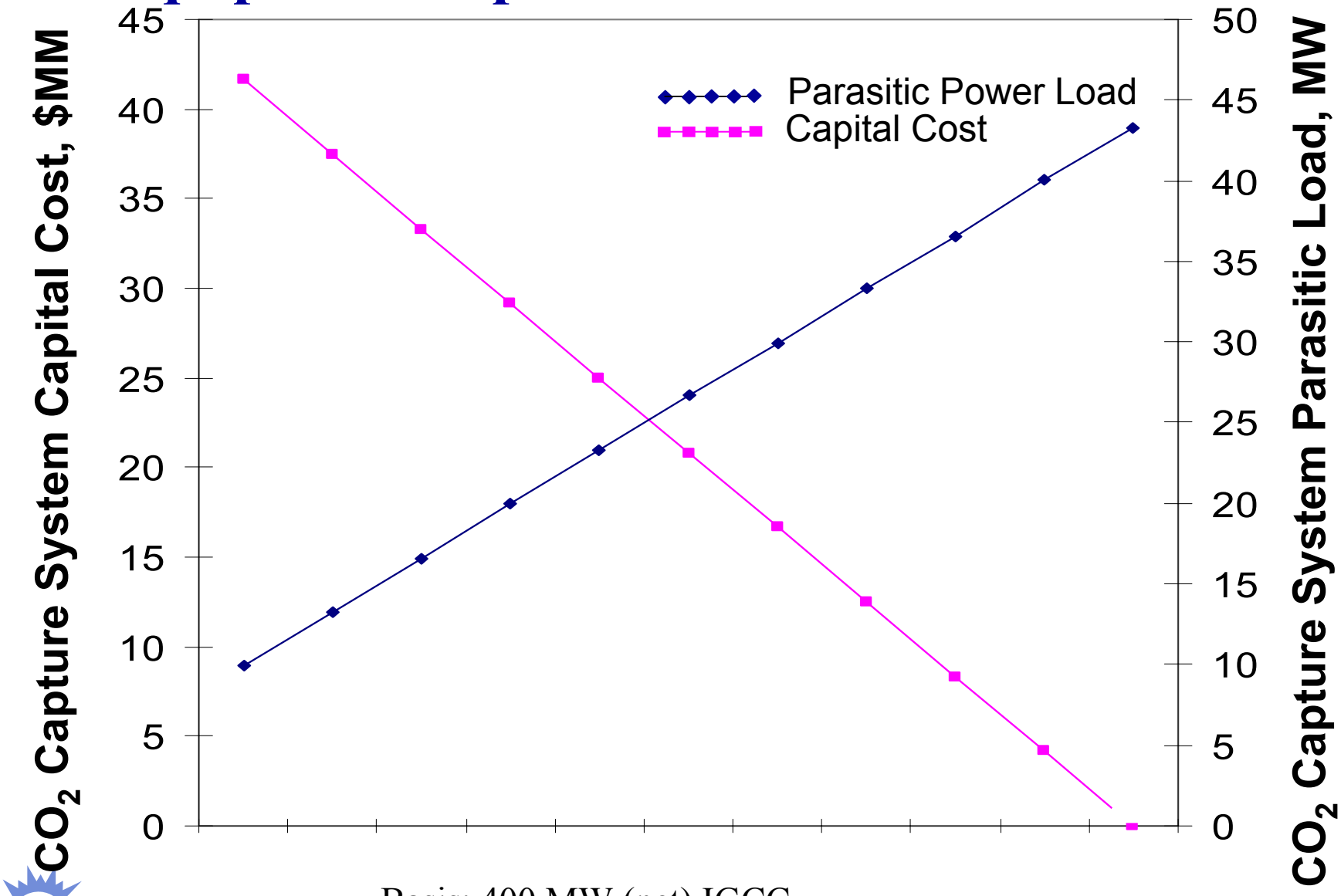

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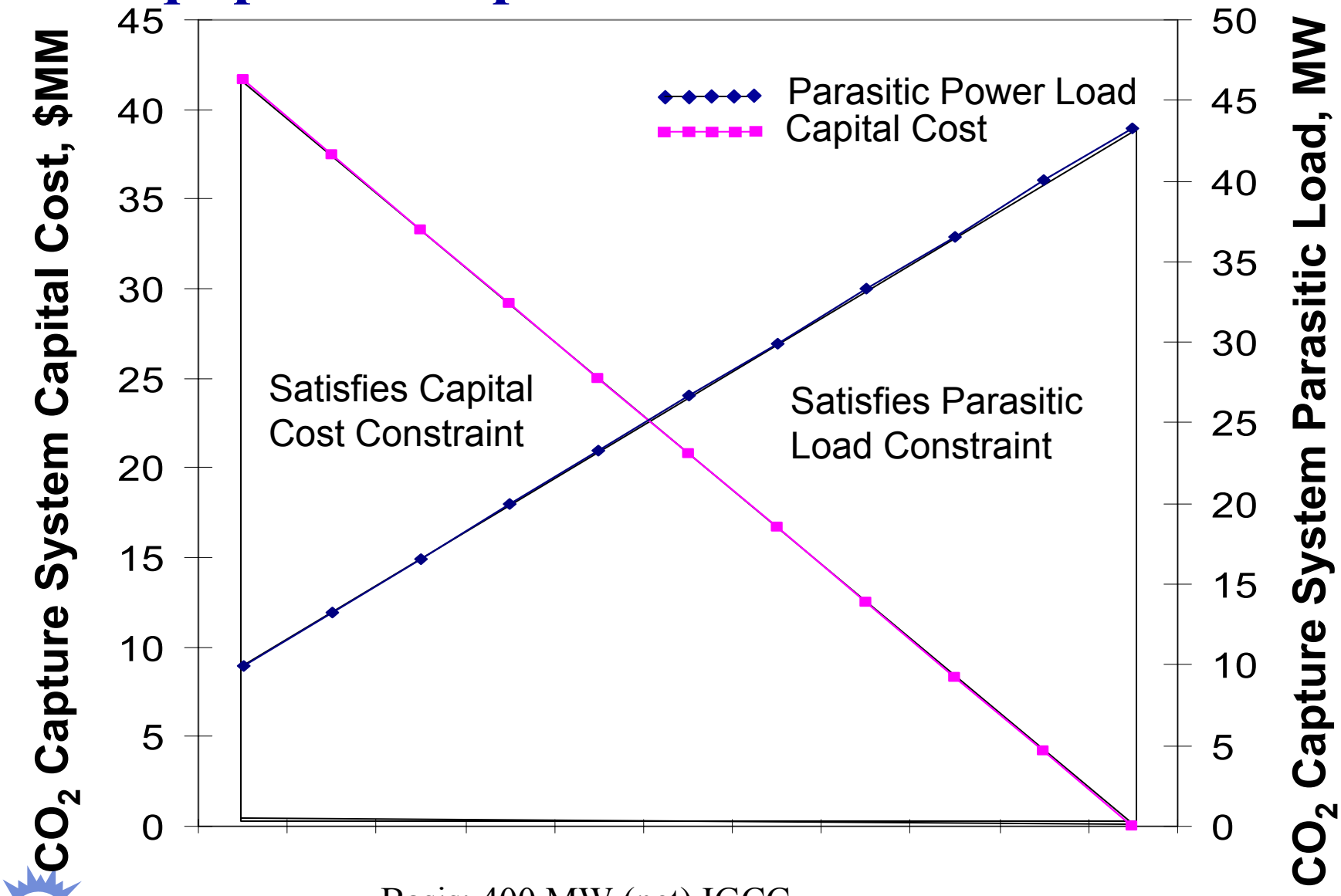

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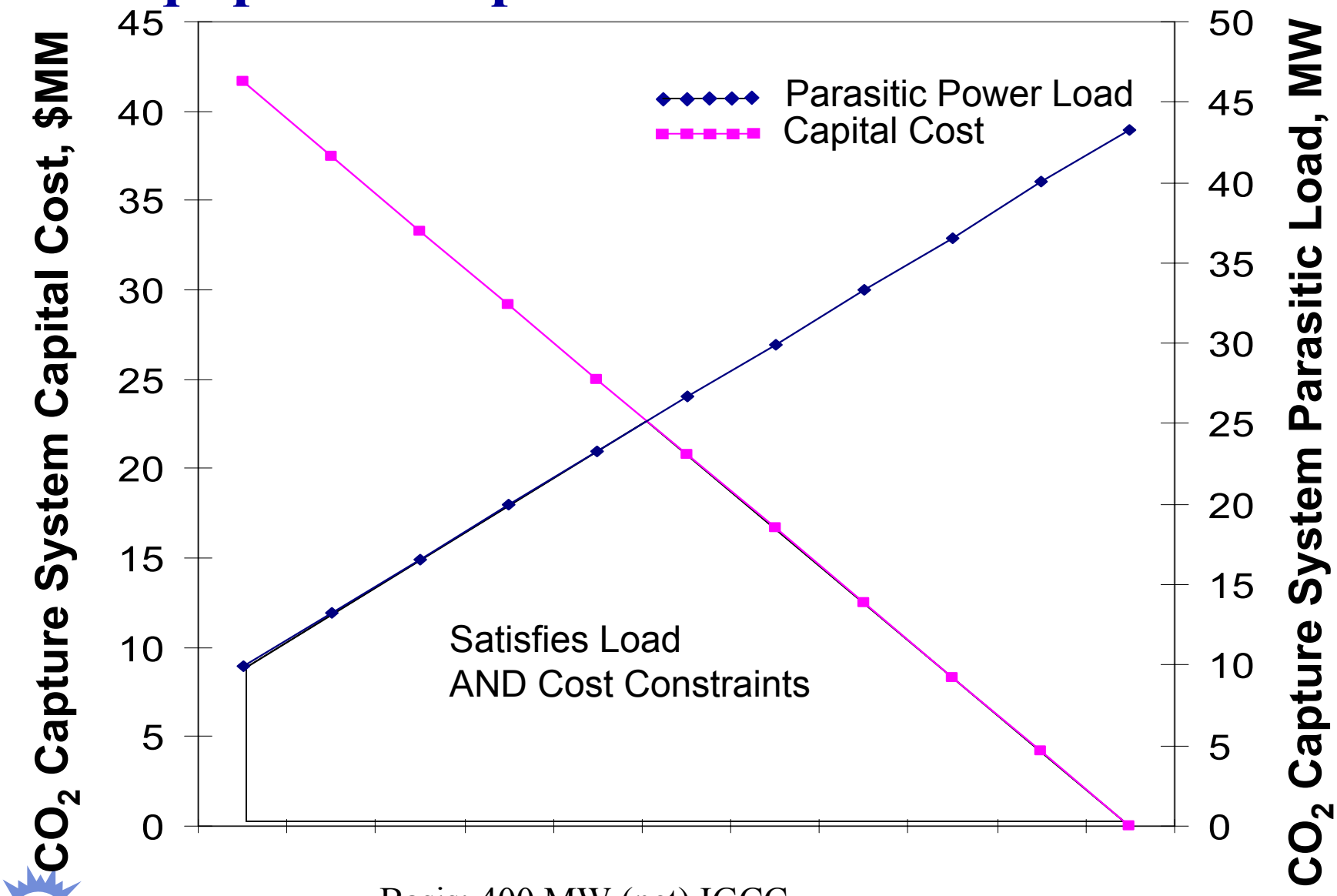

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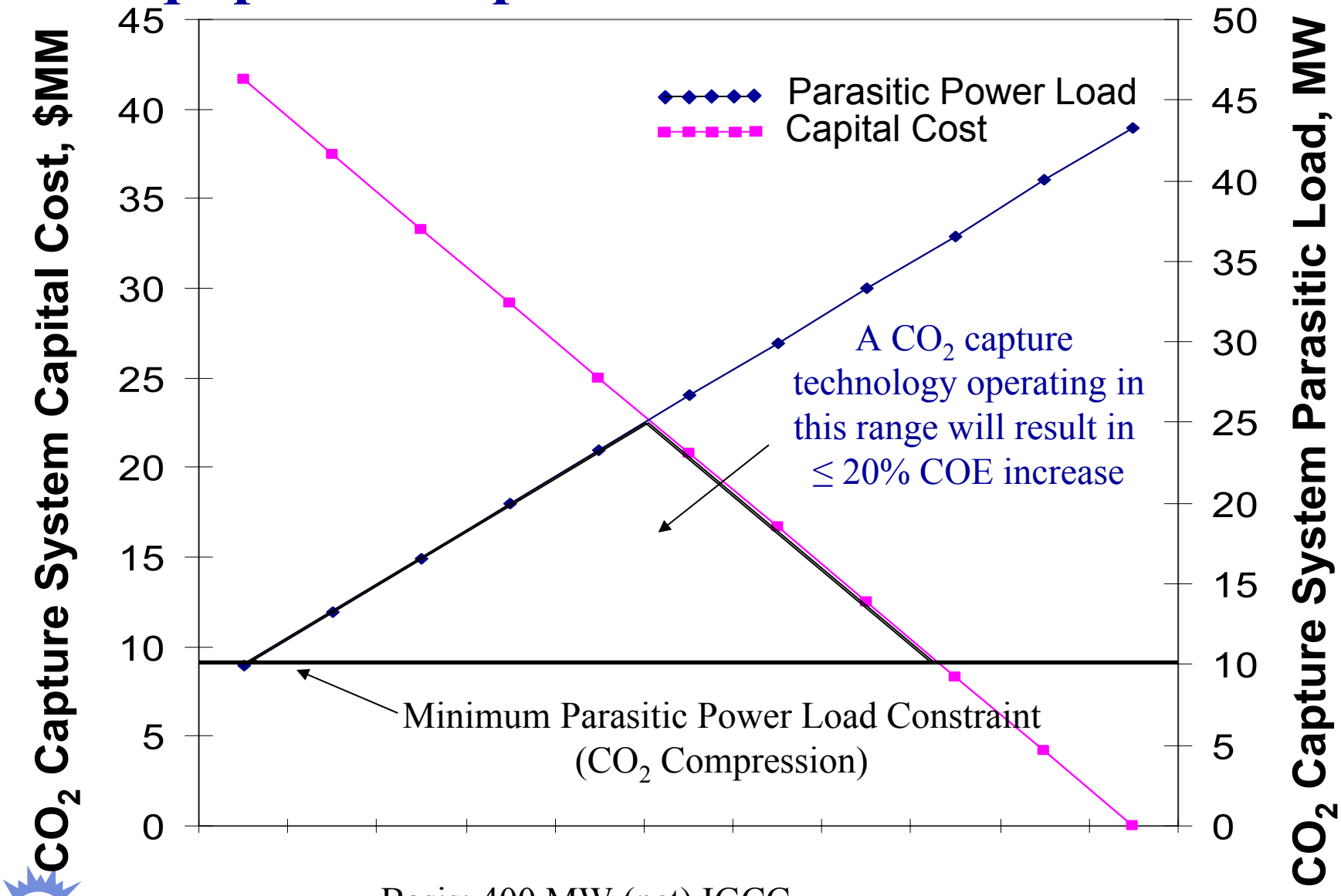


Basis: 400 MW (net) IGCC

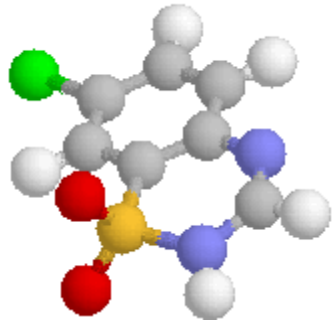
Variables Affecting COE

So far, the variables we have considered are:

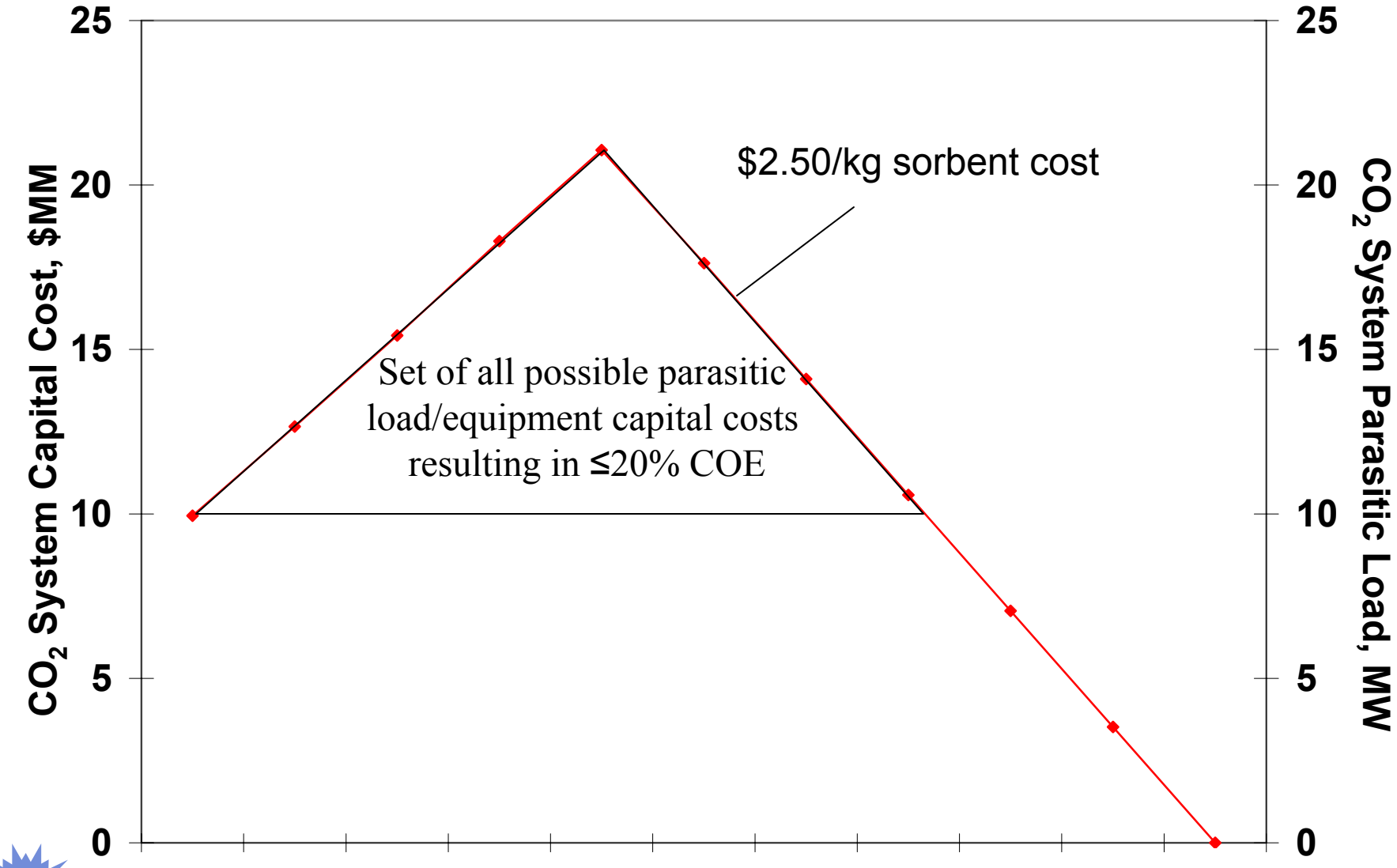
- CO_2 System Capital Cost (cost of equipment)
- Parasitic Power Load (increased coal consumption)

However, we haven't considered sorbent cost

- Assume enough sorbent for one hour cycle provided



20% COE Increase



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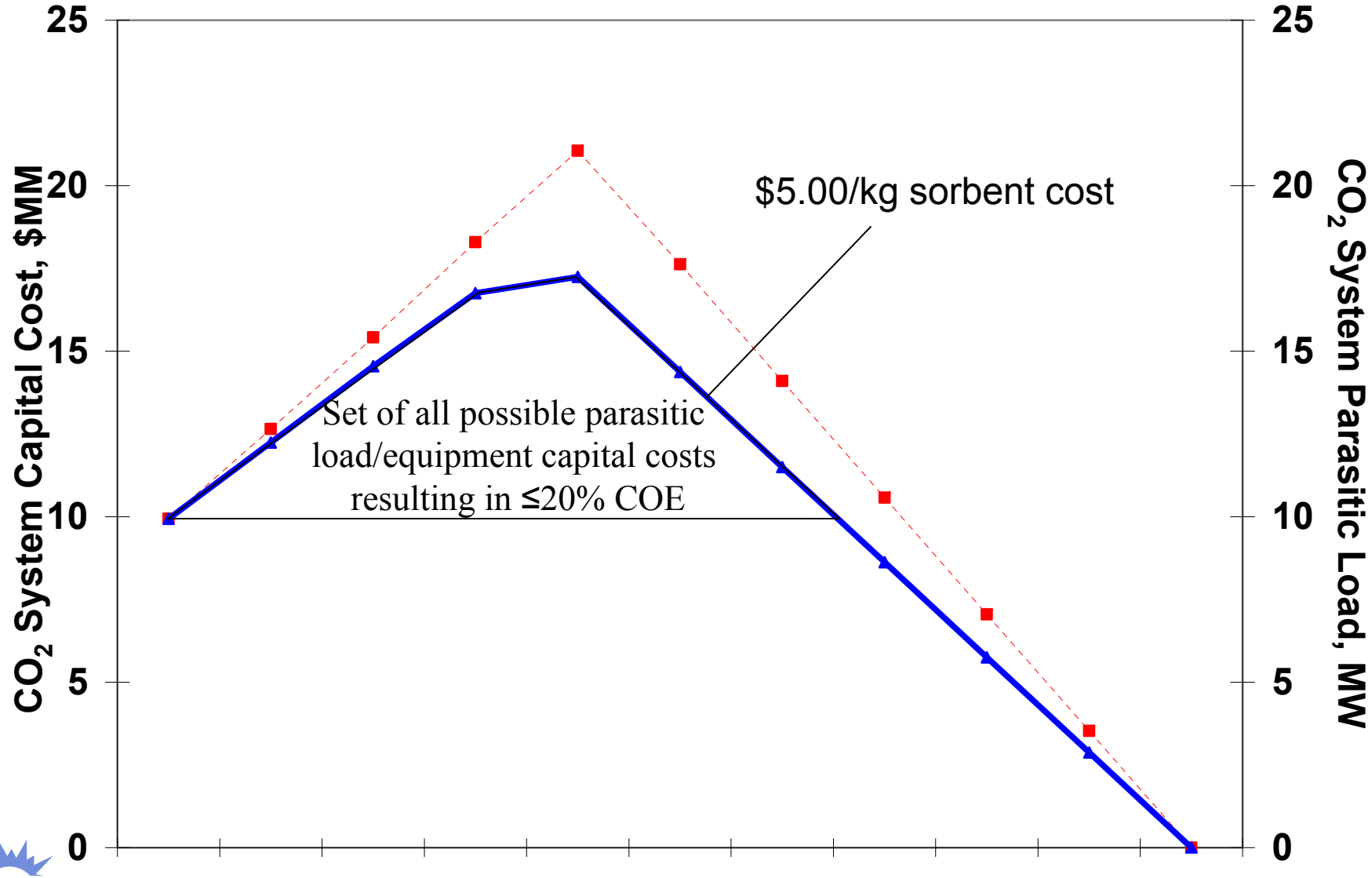

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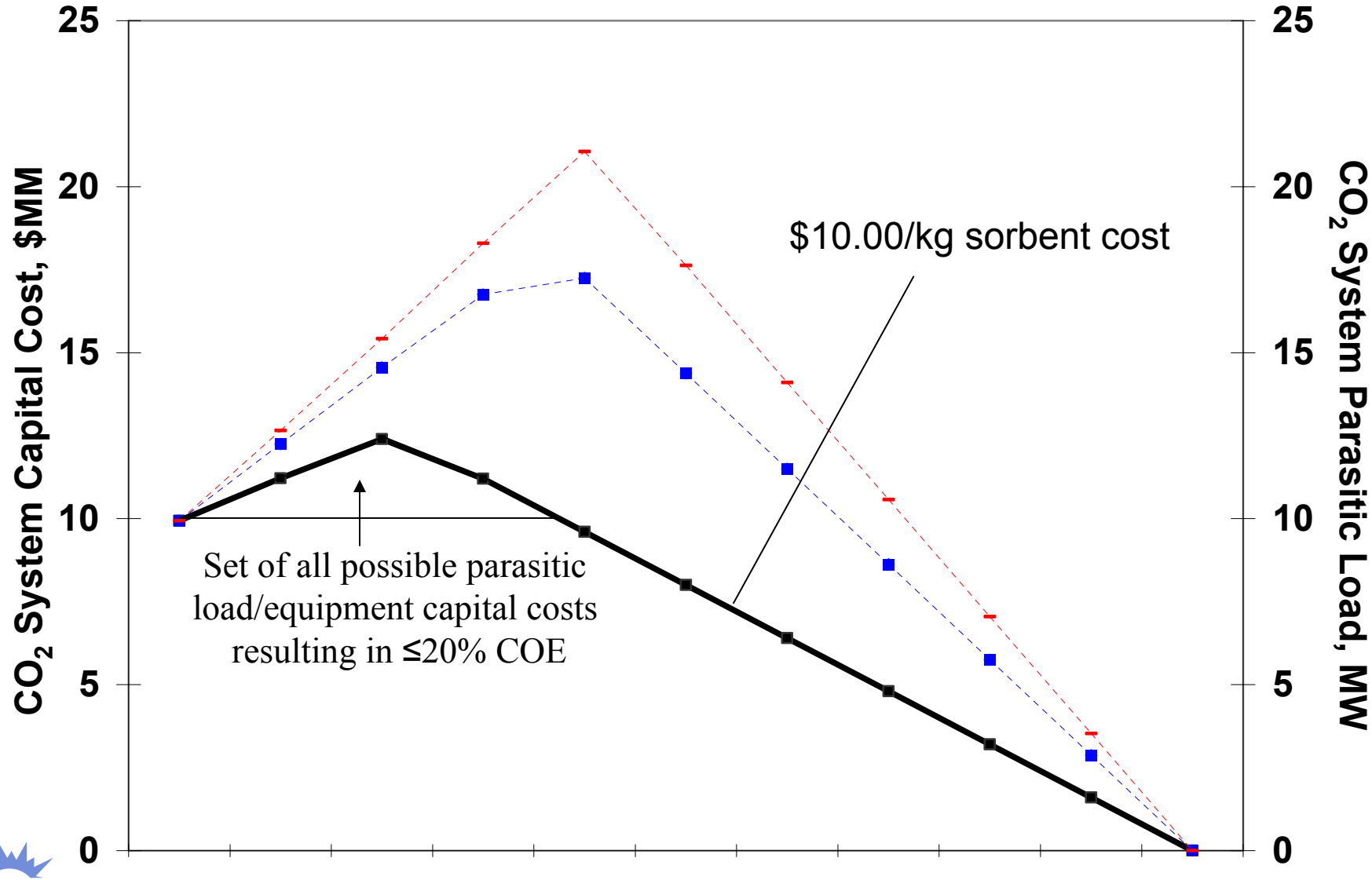


20% COE Increase

- Define envelopes of operation for sorbent cost, equipment capital cost, parasitic power load
- Curves provide a way to quickly evaluate economic impact of CO_2 removal system

Variables Affecting COE

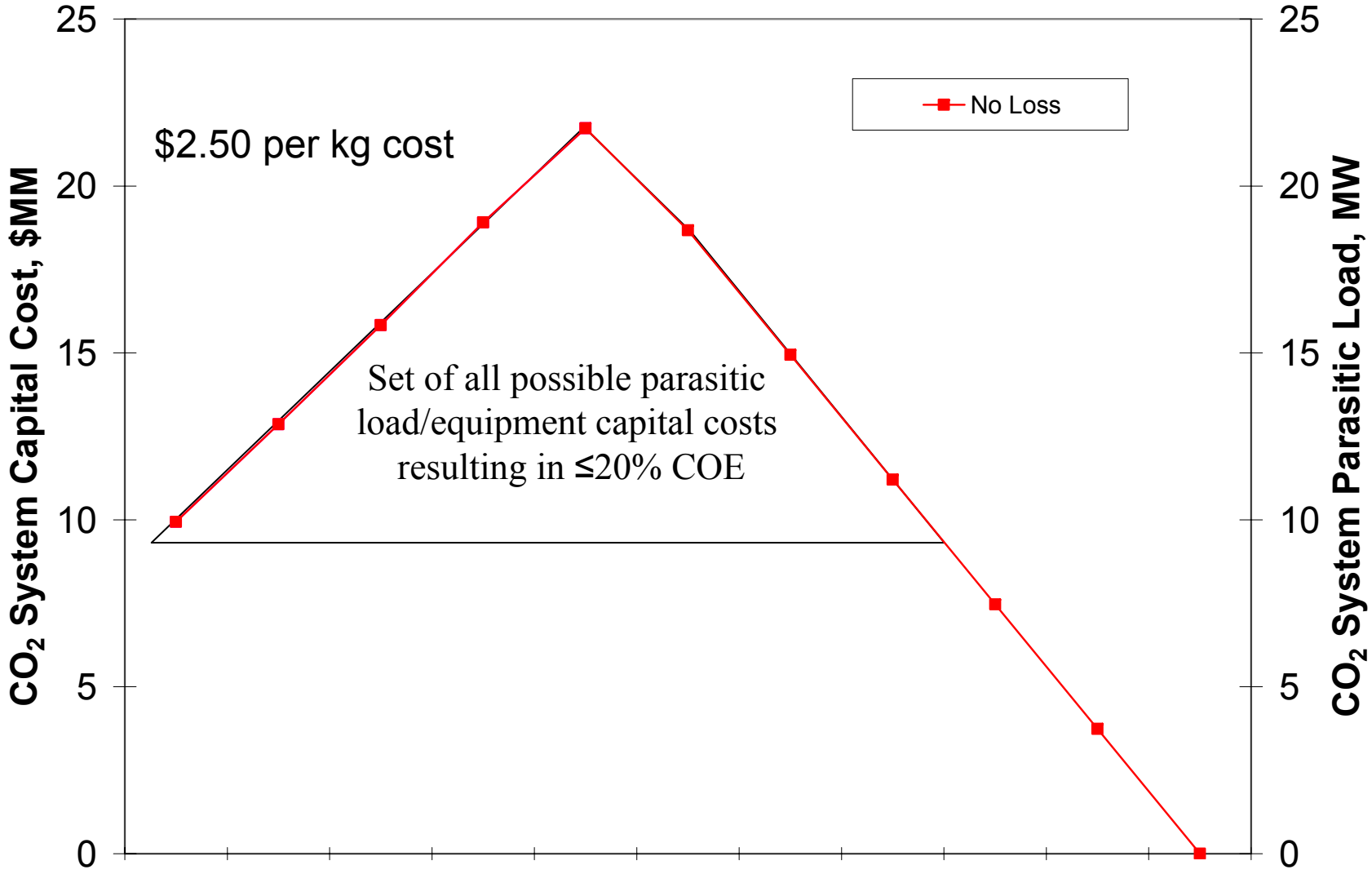
Loss of sorbent capacity due to:

- **Physical decomposition**
- **Poisoning**

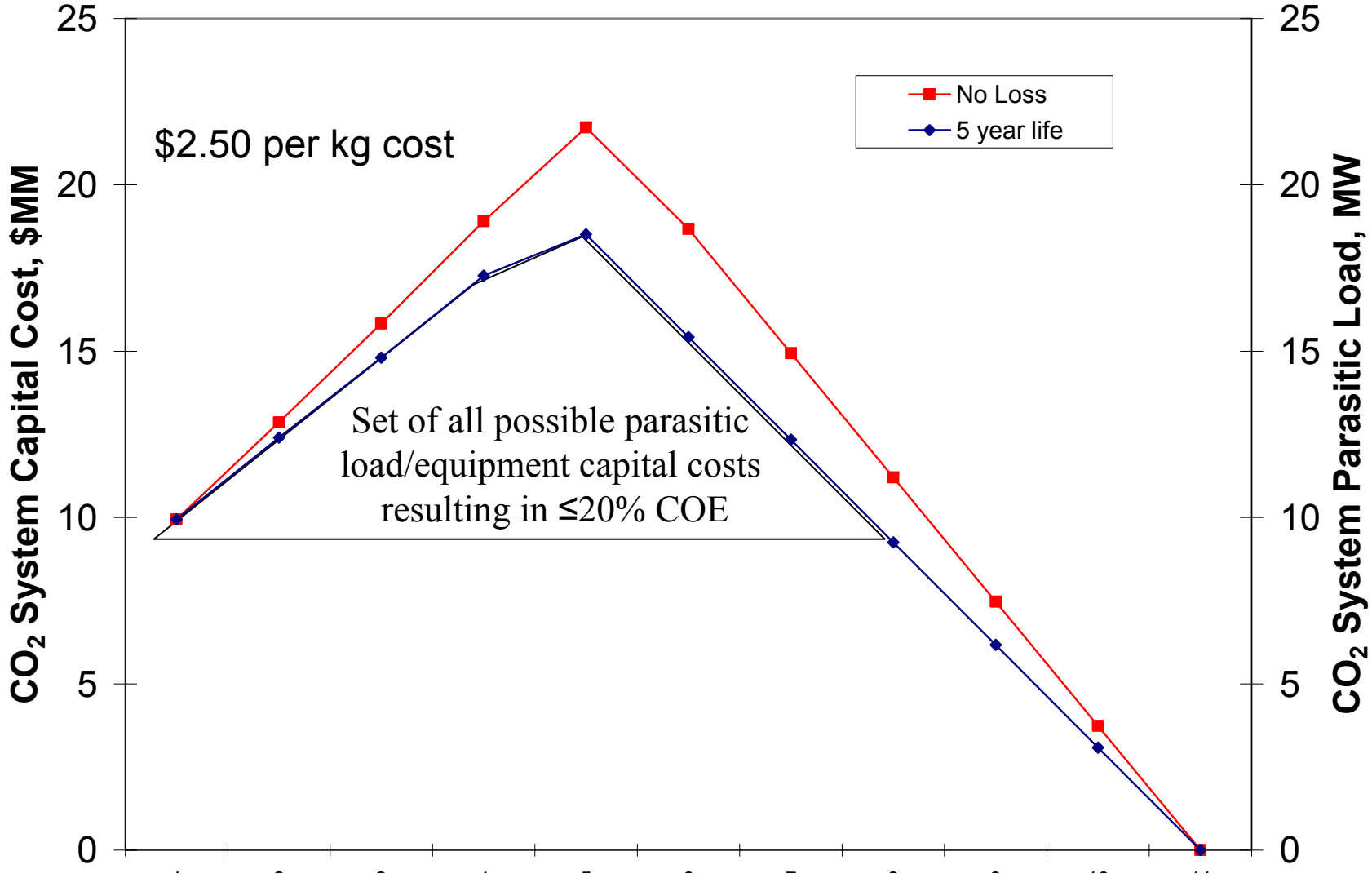
…can be an additional operating expense

How does this further constrain the system?

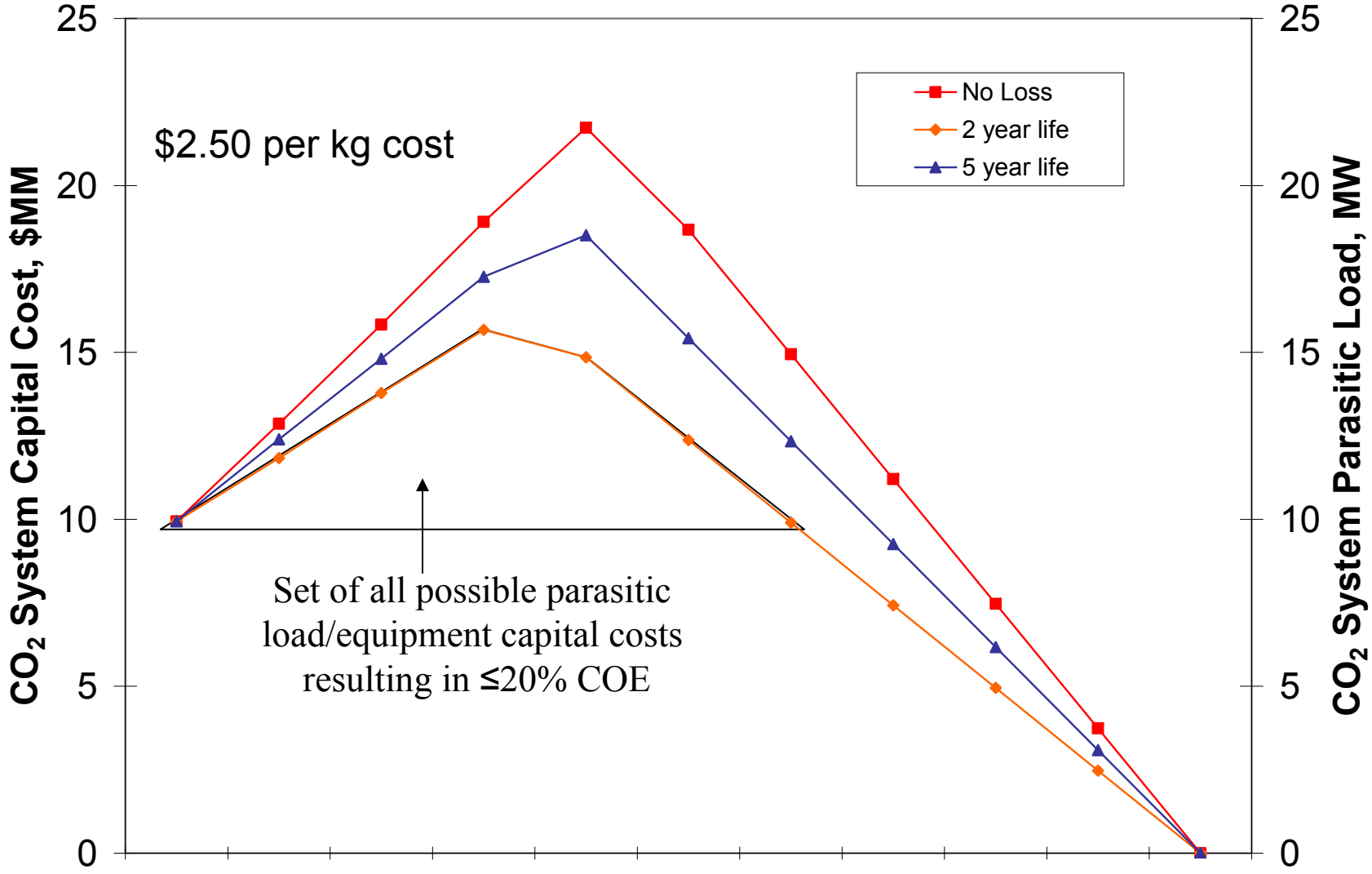
20% COE Increase



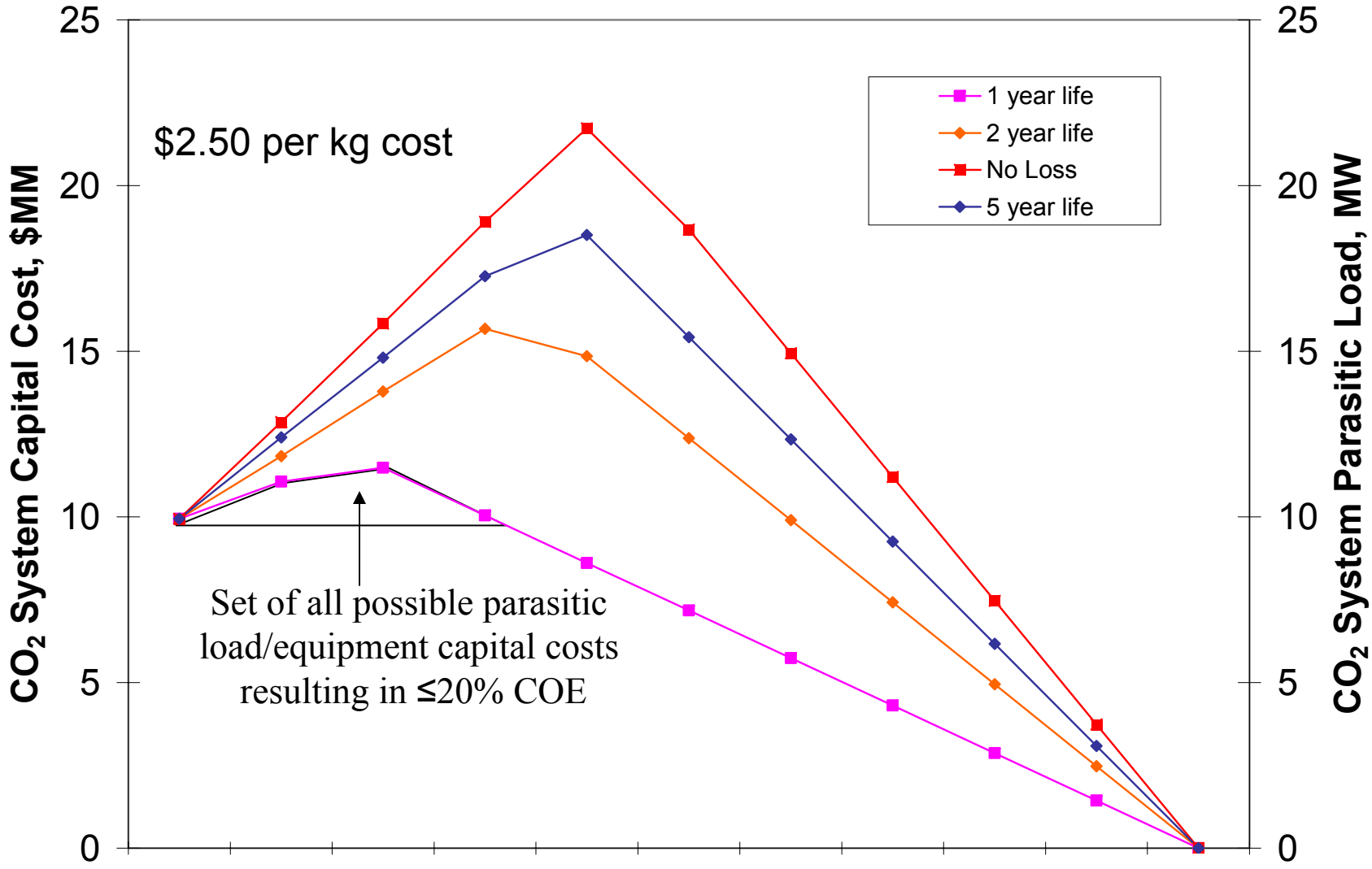
20% COE Increase



20% COE Increase



20% COE Increase



Summary

- Preliminary sorbent analysis provides targets for R&D
- Quantifies the need for inexpensive, durable sorbents
- Curves generated will allow for quick screening of CO_2 capture technologies

Future Work

- **Consider additional sorbent properties**
  - Heat capacity, absorption capacity, regeneration requirements, particle size
- **Propose possible system designs to accommodate sorbents**

Questions?